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ABSTRACT

This paper: (1) discusses why science and mathematics education are important; (2) outlines why a comprehensive improvement program is necessary; and (3) describes how North Carolina is attempting to improve science and mathematics education as related to teacher supply and quality, student enrollment and performance, curriculum and instructional resources, and innovation in public schools. Improvements related to teacher supply and quality include summer institutes, scholarships, establishment of mathematics and science education centers at universities, and other programs and changes. Improvements related to student enrollment and performance include the North Carolina Scholars Program, adding writing to the annual testing program, increased graduation requirements, and other measures. Improvements related to curriculum and instructional resources are currently focusing on the supply of qualified science and mathematics teachers and time for teaching science and mathematics. In addition, local improvement efforts (without any state support) are underway, as are Local Model Partnership programs (a combination of Reynolds foundation and state funds), the Business Committee on Math/Science Education, and the Growth Initiatives for Teachers for Mathematics and Science Pilot Program. (JN)

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MULTI-FACETED STRATEGY FOR IMPROVING SCIENCE AND MATH EDUCATION IN NORTH CAROLINA

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I. IMPORTANCE OF SCIENCE AND MATH EDUCATION

While the impact of technological change on society has implications for all of our educational programs, the challenge is most immediate in the areas of science and mathematics education. The quality of science and mathematics education is crucial to our efforts to harness science and technology for the health and prosperity of society. The N. C. 2000 report highlighted this issue:

> North Carolina's ability to utilize advances in science and technology to improve productivity, to stimulate economic development, and to enhance the quality of life for the state's citizens will depend..on ensuring scientific and technological literacy in the general population...A strong emphasis on more math and science instruction for all students is necessary.

Science and mathematics education will play a particularly important role in the coming years for three reasons. The first is the rapid expansion of new technology industries. North Carolina has recently experienced great success in attracting and nurturing the growth of new technology industries. A key component in this success is the availability of technically trained manpower.

Much of our success can be attributed to our outstanding community college and university systems. However, if we are to continue to compete successfully with other states and regions for these industries, and the jobs they create, strengthening the quality of science and mathematics programs throughout North Carolina in grades K-12 must become a statewide priority.

Nevertheless, the total number of new technology jobs created will not ensure employment for everyone. Therefore, the second argument for strengthening K-12 science and mathematics education is the significant impact of technical advances on traditional industries and work roles. In North Carolina, this impact is already being felt in traditional industries such as textiles, agriculture, furniture manufacturing, banking and commerce. For these traditional mainstays of the state's economy to remain healthy and continue to grow, the technological literacy of the general workforce must be raised. The entire workforce -- from the most junior millworker to the senior managing director -- must be able to rapidly adapt to new technologies and utilize them for maximum productivity.

Third, science and mathematics education must be strengthened if the impact of scientific and technological change on society is to be beneficial to all of our citizens. Scientific and technological literacy is crucial to our state if we are to make the best public and political judgements regarding the issues raised by this technological transformation, if we are to sustain our investment in basic research and development in the state, and if we are to assure every citizen of the right to full participation in a technological society.

II. IMPORTANCE OF COMPREHENSIVE APPROACH

A. No "quick-fixes"; no "single-fixes". Recommendations like those included in the Southern Regional Education Board report, "Meeting the Need for Quality" and in many other reports should not be viewed as a shopping list of options; all must be pursued if lasting improvements to result.

B. Importance of Fundamentals

1. Primary reading program

2. Competency testing program

C. First Steps in Science and Math Education

1. North Carolina School of Science and Math -- 2 goals

(a) Excellent education for students at school

(b) Improve science and math education throughout the state

2. Board of Science and Technology/State Board of Education Committee

(a) Report and recommendations of July 1982. These are summarized in Attachment A.

(b) With the help of people like those N. C. legislators that are here today and many other educators and business leaders throughout the state we've made outstanding progress---while much more still needs to be done.

D. Governors Task Force on Science and Technology

1. Continuing work beyond initiatives and recommendations summarized here; comprehensive strategy and plan for improving science and math education

2. Task Force concerned with elementary and secondary education, research and higher education, and technological innovation

III. FOUR COMPONENTS TO CONSIDER IN IMPROVING SCIENCE AND MATH EDUCATION

A. Teacher Supply and Quality

B. Pupil Enrollment and Performance

C. Curriculum and Instructional Resources

D. Innovation in Public Schools

I will go through each area and briefly describe what is underway in North Carolina.

I will not go through the litany of statistics that demonstrates the deficiencies that exist in each area in North Carolina. Suffice it to say that in NC, as in the nation as a whole, significant improvements are necessary.

IV. TEACHER SUPPLY AND QUALITY

A. The issue of teacher salaries has attracted much of the attention when considering how to improve the supply and quality of science and math teachers. Salary alone, however, is not the only factor affecting the recruitment and retention of science and mathematics teachers. In a recent survey of North Carolina science teachers, over 70% said that salary would be "a serious consideration" in determining whether or not they stay in teaching; but over 90% said that salary alone would not determine whether they remained in the schools. Other important factors include working conditions (such as the availability of equipment, materials, facilities, and time for

effective laboratory centered instruction), the level of support received from local administrators, opportunities for professional development, and the number and type of non-instructional duties expected of teachers.

Ultimately, solving the physical science and mathematics teacher shortage will require solving the problems of the teaching occupation. That is, a healthy occupational structure to promote and reward excellence is as important as higher pay. This goal of restructuring the teaching profession is a long-term strategy; over the short-term we must get more qualified science and math teachers into the classroom. Steps underway in North Carolina include:

B. Summer Institutes to retrain hundreds of science and mathematics teachers in grades 7 and 8 and certify those who have been teaching out-of-field were begun in the summer of 1983. These institutes, funded by a combination of staff development funds from the State Department of Public Instruction (SDPI) and a new appropriation from the general assembly, are underway on a number of college and university campuses across the state.

C. 100 scholarships of $1,000 each for science and mathematics teachers in grades 9-12 were provided by an appropriation from the General Assembly for fiscal year 83-84. These scholarships are intended to update these teachers' training in science and mathematics.

D. Math and science education centers at colleges and universities are being established as permanent units for addressing the quality and supply of middle school and high school science and math teachers.

The centers will be operated through partnerships between high schools and the colleges. Planning has been completed; two centers will begin this fall--at UNC-Chapel Hill and UNC-Charlotte. The goal is to have 7 centers operating by the end of the 1985-86 school year.

E. N. C. School of Science and Math Teacher Center Program for elementary school teachers is being developed now with a planning grant from the Ford Foundation. The program would bring teaching resources and training to elementary science and math teachers throughout the state. A proposal for implementation of the program will be submitted to the Ford Foundation.

F. The Scholarship Loan Fund, a loan forgiveness program established in 1957, provides scholarships of $1500 per year to prospective teachers which are forgiven for equivalent years of teaching service in North Carolina. The State Board of Education recently assigned first priority in this program to prospective science and mathematics teachers.

G. 100 new teachers for innovative math, science, and computer science programs will be hired through a special appropriation of $2.1 million by the General Asembly. No more than 2 of these teachers can be hired in any one county. Special attention will be given to hiring these teachers in districts where there are shortages.

H. Certification policy changes. At the May, 1983 State Board of Education meeting, a new In-field Assignment Policy was adopted. Until this time, there were no laws or rules regulating out-of-

field teaching in North Carolina. This new policy requires, as of the 1983-84 school year, that all teachers hold a certificate or provisional certificate in their area of major assignment (1/2 day or more). A provisional certificate requires that the teacher be working towards a certificate in that field at the rate of at least six (6) semester hours of earned credit per year.

In addition, if a teacher is assigned to teach a course for less than half a day, she/he must hold at least an endorsement or provisional endorsement in that field. This endorsement would be based on 18 semester hours of coursework in that subject. A provisional endorsement would be granted for only one year to a teacher who is working toward endorsement in the field.

Changes also were made in the types of certificates awarded. The old system: K-3, 4-9, and 7-12; general certificates in K-3 and 4-9, and certificates for subject areas in 7-12. The new system: general certificates for K-3, and 4-6; certificates in subjects for 6-9 and 9-12. This new system overcomes the old problem of having teachers with 4-9 certificates "certified" to teach any subject regardless of college training and background.

Additional Changes in certification have been recommended by the Governor's Task Force on Science and Technology--redefining secondary science certificates, providing for elementary school science specialists, and modifying procedures for certificate renewal are areas of concern.

I. Quality Assurance Program. The Framework for this program, developed by the State Board of Education and the UNC Board of Governors,

includes:

1. The development of screening procedures to ensure that college students meet acceptable standards in general education such as English, literature, fine arts, social studies, mathematics, and science before admittance to teacher preparation programs.
2. Clarification of the competencies to be included in teacher preparation programs "in order to produce competent and effective teachers."
3. The development of a more effective, more systematic student teaching program.
4. The development of a test "which would serve as part of the final pre-service evaluation and would be a prerequisite for initial certification."
5. The development of an evaluation system for use with all individuals under initial certification prior to the granting of continuing certification to them.

J. Duty-free Lunch Periods will be provided for all teachers.

K. With regard to the long-term need for restructuring the teaching occupation, the General Assembly approved the pilot project in the Charlotte-Mecklenburg School System, which will begin implementation in the 1983-84 school year. The plan creates a career structure to increase opportunities for promotion, economic gain, and public recognition and honor for exemplary teachers. The plan involves definite career stages for classroom teachers with differentiated responsibilities, training, and rewards. You will hear much more about this program in the afternoon session.

V. PUPIL ENROLLMENT AND PERFORMANCE

A. Enrollments declining; many students not taking key "gatekeeping" courses like physical science and Algebra I. Strategies for improvement:

B. The North Carolina Scholars Program, recently adopted by the State Board of Education, is a recognition and incentive program designed to encourage students to take a more rigorous course of study in high school. Students qualify for the program by performing satisfactorily in a number of designated courses beyond minimum graduation requirements, including 4 units of math, 3 units of science, 3 units of social studies, and 4 units of English.

C. Writing added to the annual testing program. The Governor's Task Force on Science & Technology is recommending that science also be added.

D. Programs sponsored by the North Carolina Science Teachers Association, the North Carolina Council of Teachers of Mathematics, the North Carolina Student Academy of Science, and the State Department of Public Instruction include competitions and conferences for fostering student interest in science and math.

E. Math Counts is a statewide competition involving local, district and state mathematics competitions for students in Grades 7-8. This new program is sponsored by the Professional Engineers of North Carolina and is an outstanding example of a working partnership for school improvement.

F. Science and Math Curriculum Studies recently have been completed. Recommendations include development of courses appropriate to

students with different interests and increased requirements for science and math courses. In light of the increased science and math requirements, it is critically important that substantial effort be devoted to developing courses appropriate to the range of student interests.

G. The North Carolina Council for Minorities in Science, Mathematics and Engineering has recently been formed to strengthen local partnerships among public schools, business and industry, and colleges and universities to promote minority participation and excellence in coursework leading to technical training and degree programs and careers. Programs involve role models, tutoring, plant tours, club competitions, summer employment, teacher inservice, summer camp and educational opportunities in science and mathematics for students.

H. Increased Graduation Requirements. The State Board of Education recently raised the state minimum graduation requirement from 18 to 20 units. These two additional units are undesignated, but it is hoped that many students will take mathematics and science courses in addition to the two units of each which are currently required.

VI. CURRICULUM AND INSTRUCTIONAL RESOURCES

A. Two important curriculum and instructional resources available in limited supply are time and qualified science and math teachers. One important step to redress these deficiencies was approved by the 1983 session of the general assembly:

> Extended Employment of six additional weeks has been provided for 350 lead teachers in science and mathematics, one in each of the state's high schools.

These teachers will provide leadership to local efforts for improving science and mathematics education through assisting in curriculum development, preparing special teaching units, teaching special classes, and involving higher education, industry, and community personnel in the school improvement efforts.

B. Also addressing the time issue, two pilot projects were approved for extending the school day (7 hours) and the school year (200 days).

C. The Science and Math Curriculum studies, mentioned earlier, include far ranging recommendations for strengthening science and math programs in grades K-12. New and modified curricula must be developed.

D. There was an increase of $2/pupil in the appropriations for instructional supplies. The Governor's Task Force is now completing a state-wide survey on the status of and needs for equipment for science and math courses.

VII. INNOVATION IN THE SCHOOLS

At the heart of many of the difficulties we face in public education is the loss of public confidence in our schools, the lack of consensus on our goals for school improvement and therefore our lack of commitment to seeing these improvements through. If we fail to address this fundamental problem, all other action we take will be of limited and temporary benefit.

We must begin immediately to rebuild the public consensus on the aims and role of education and commitment to make the tough choices and investments to assure educational excellence.

Accomplishing this task will involve creating a sense of shared ownership of schools by the entire community, focusing on ambitious, but achievable goals for school improvement, and building a track record of success in these efforts.

The strategy we adopt must focus on public involvement in local school improvement efforts, with support from the state. Confidence will be developed in the context of successful actions and programs for school improvement.

A number of examples of this strategy already exist.

A. Local improvement efforts in science and mathematics education are now underway without any state support in Charlotte-Region VI, Greenville-Pitt County, Greensboro-High Point, the Wilmington area, the Roanoke Rapids area and elsewhere. The key elements of these successful programs are:

1. the formation of a planning and resource team composed of educators, business leaders, and other community leaders to plan programs for school improvement,
2. a focus on concrete, achievable objectives,
3. using, to a large extent, local resources to solve local problems in these areas of instruction,
4. a focus on action rather than unresolvable issues.

B. Based on these experiences, a combination of Reynolds Foundation and state funds were recently made available as seed money for additional Local Model Partnership programs. Two-year improvement projects in 8 schools have received approximately $50,000 each to involve local business and industry, public school leadership, local government, colleges and universities and others in these efforts. These programs should both have a concrete, significant impact on local science and math programs and rebuild the public confidence and commitment to excellence in their local schools. This change in attitudes should translate into the political commitment to make the

difficult change and sustain the investments necessary to improve public education.

C. The Business Committee on Math/Science Education was formed by the Governor in Spring 1983 to work with the business community, public schools, education leaders, the governor and others in promoting partnerships to strengthen science and math programs. Already this committee of about 30 leading corporate executives has developed a number of recognition and scholarship programs for teachers, a recognition program for outstanding business contributions to science and math education, and a task force to promote working partnerships at the local level throughout the state.

D. Growth Initiatives for Teachers for Mathematics and Science Pilot Program was recently initiated in N. C. through support by the GTE Corporation. Because of Governor Hunt's leadership in stressing the need for improvements in education -- specifically in math and science --and because of the initiatives in the Local Model Partnership Programs described above, North Carolina was chosen for this pilot program. The program will involve 22 teachers:

- 2 from each of the 8 Model Programs (16)
- 2 from the N. C. School of Science and Math (2)
- 2 from each of 2 private schools (Durham Academy and Forsyth Country Day) (4)

The Program includes the following features:

- fellowship grant to each teacher of up to $2500 for advanced training at a graduate school or in-service program
- stipend to each teacher of up to $2500 for travel and living

expenses while studying

- an implementation grant of $2500 for use in the teacher's home school to be matched by $2500 from the school system
- participation by teachers in a conference with GTE scientists to address "real world" needs in science and math.

VIII. SOME OTHER CONCERNS

A. The Governor's Task Force on Science and Technology is now in the final stages of formulating and approving recommendations to go beyond these initial steps to a 4-5 year strategy for improving science and math education.

B. This strategy includes a much stronger emphasis on the elementary school than I have given today in reviewing steps already underway. Of particular concern is strengthening "hands-on" science activities in the elementary school. To accomplish this, proposals are put forth for improving pre-service and in-service teacher training in science and for establishing a new certification category for elementary school science and math specialists who would serve as resource persons and provide leadership for the elementary science and math programs.

C. The Task Force already has sponsored workshops for elementary school principals and middle school guidance counselors and is recommending further activities with these individuals as part of its comprehensive strategy for improving science and math education.